Judged from the book alone, it is perfectly clear that Dr. Wood is well qualified to write upon the subject he has taken up. Although some of the subjects are dealt with sketchily enough, he gives the impression that he has had experience; that he has worked in the field; that he has kept his eyes open and knows generally what should be done and how to do it. The American health officer and student of public health topics may very safely take him as a guide. The English health worker even may find something of value in what he has to say, though he has no reference to English works and workers, and his viewpoint is purely American, and his methods, most of them, not such as are or could be applied in this country.

The book is not a large one, but Dr. Wood covers the greater part of the field of health work, dealing with such subjects as statistics; control of communicable diseases; child welfare; school hygiene; pure foods, etc.

The treatment throughout is practical, and the writing is good and attractive. The same may be said of the illustrations, of which there is a fair number. As already hinted, it is unlikely that Dr. Wood's book will have more than a limited appeal in this country, but it will probably receive a good welcome from and be found useful by health workers in the United States.

The Study of the Weather. By E. H. Chapman. (The Cambridge Nature Study Series.) Pp. xii+131. (Cambridge: At the University Press, 1919.) Price 3*s*. 6*d*. net.

THIS little book on elementary meteorology will be welcomed by the school-teacher, to whom it makes its primary appeal. Though the serious student of the science may at first feel that it has no place on his shelves, yet, should he at some time be called upon to lecture to a non-scientific audience, he will find a perusal of its pages of no small value. The matter dealt with is mainly confined to features of the weather which can readily be observed by young people without special apparatus, and it is presumably for this reason that any reference to pressure and temperature conditions in the upper air is omitted. With the foregoing rather notable exception the groundwork of meteorology is well covered. One of the chief features of the book is the series of exercises, of which more than 250 are given. These vary from some very simple questions to others which the teacher would be well advised to think out carefully before putting to his class if he wishes to avoid finding himself in an awkward position. Many of these questions are calculated to arouse a most healthy interest in the minds of the pupils. One example must suffice. "What kind of weather is it that causes the inside walls of a building to stream with moisture?"

The Cambridge University Press is to be congratulated on the clearness of the printing and the excellence of the get-up of the book. The frontispiece is particularly pleasing. Numerous illustrations and charts are included in the text.

J. S. D.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Percussion Figures in Isotropic Solids.

IN the issue of NATURE for October 9, Prof. C. V. Raman, of Calcutta, illustrated the conical fracture produced by the impact of a steel ball on a plate glass surface.

The following observations, which may be regarded as supplementary, were made by the writer some time ago with the object of finding what really happens when a glass surface is being ground, or, as it is technically termed, smoothed by an abrasive such as carborundum. Individual grains of a good abrasive have a nodular form, and the abrasion of glass appears to arise from the impact or pressure of the grains.

Two polished surfaces of glass were placed face to face with a few grains of carborundum between them, and the specimen was compared with a similar one in which steel balls of 1 mm. diameter were substituted for the carborundum. Pressure was applied uniformly over the whole surface, and while the pressure was being applied, the plates could be translated one over the other, thus producing the actual machine conditions. The observations were made by means of a polariscope. As the appearances were identical, steel balls were used throughout the later experiments, thus enabling the conditions to be better controlled.

It will be assumed that the polished appearance of glass is due to an amorphous surface layer. When the surface particles are acted upon by mechanical forces, the molecules, or possibly groups of molecules, rearrange themselves, the result being akin to the surface of a liquid. This conception was first advanced by Lord Rayleigh, and there is now a large mass of supporting evidence. When a piece of glass is worked mechanically, the surface molecules are so profoundly agitated that they are able to rearrange themselves under the action of intermolecular forces.

Fire glazing similarly consists in thermally agitating the molecules. Very small forces are sufficient to weaken the molecular cohesion by the required amount. Chemical action may produce a similar result. An optical surface may be reduced quite uniformly by the action of HF, provided the fluorides as formed are not allowed to crystallise and the bath is kept in continuous movement. When a piece of glass is fractured comparatively slowly, the forces at the edge of propagation of the fine crack must be very great, and, as before, the molecules are able to flow or rearrange themselves to form a polished surface layer. But when the fracture takes place suddenly, and almost explosively, as, for example, in the cooling of a pot of optical glass, portions of the surface may have a matt appearance to the unaided eye. This type of matt surface has been discussed very fully by M. Charles de Freminville, of Paris, who regards it as a type of multiple fracture. This explanation is more probable than the alternative one that the time of fracture is too small to permit of viscous flow.

When a steel ball is pressed lightly on the polished surface of a glass block, the appearance, when viewed between crossed Nicols, is as in the diagram (Fig. 1). The central black cone has an angle of about 20°, which remains practically independent of the pressure of the ball. The cone of strain *b, b* has an angle of about 90°. Some surface light is visible at *d* and *d*. At low pressures the dark cones *c* and *a* merge softly into *b*. As the pressure is increased, the interfaces become more intense and clearly defined, but the angles do not appreciably alter. The central cone proceeds from the surface first as a rod or filament of a remarkably black intensity.

Further gentle increase of pressure causes the surface layer to rupture as indicated in Fig. 2, which is a photograph of a surface repeatedly ruptured by gentle impact. If the Nicols are paralleled, black rays will be seen proceeding from the edge of the crack as in Fig. 3, their direction indicating that the crack is normal to the surface and merely superficial. The Fig. 1 appearance remains unaltered.

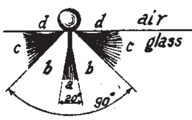

FIG. 1.

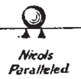

FIG. 3.

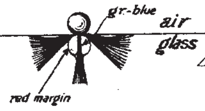

FIG. 4.

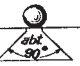

FIG. 5.

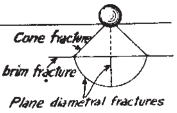

FIG. 6.

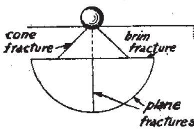

FIG. 7.

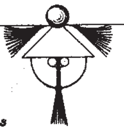

FIG. 8.

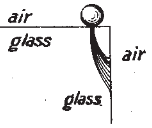

FIG. 9.

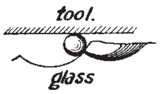

FIG. 10.

A new phenomenon makes its appearance when the pressure is again increased. Immediately under the ball there appears, as in Fig. 4, a sphere pierced by the filament of the cone *a*, and having a black outline tinged with red on the outside. The interior is filled with green-blue light, otherwise the general appearance of Fig. 1 remains unaltered. If now the Nicols are paralleled, the conical fracture (Fig. 5) previously illustrated by Prof. Raman will be seen, and by examination at intermediate positions of the Nicols, it will be evident that the cone fracture which takes place along the surface of *b* is tangential to the sphere which it encloses. The fracture can be extended up to a limit which it is difficult to exceed, even by a great increase of the rate of application of the pressure.

If the pressure is increased again, the crushing point is soon reached. The glass under the ball collapses almost explosively, a faint click being audible, and the ball sinks deeply through the surface. The cavity thus produced is lined with a snow-white layer of powdered glass.

On the polariscope at the moment of fracture several interesting developments may be observed. First, as the result probably of the greater area of pressure contact, the cone of light *b* broadens out laterally; secondly, the cone fracture may extend horizontally like the brim of a hat, thus definitely terminating the depth below the surface; and thirdly, the space within the cone becomes cleft by two fracture planes apparently normal to one another, and having their line of intersection on the axis of the dark cone *a*.

If only one diametral plane appears, the other may be developed by an increase of pressure. Sometimes the second plane is terminated at the axis, but it can always be extended across the first plane. The appearance of the fractures is now as indicated in Fig. 6. If the diametral plane fractures terminate at the base of the cone, they may be extended by pressure to the end of the rim, as in Fig. 7.

Under crossed Nicols two new coloured spheres identical with the original one may make their appearance just under the base of the cone fracture, as in Fig. 8, indicating the existence of subsidiary fractures.

But if a polished transverse section of a glass plate smoothed with carborundum is observed microscopically, it will be seen immediately that surface conchoidal fractures predominate, and that, if cone fractures do exist, they are very shallow.

In the workshop process of smoothing preparatory to polishing, the smoothing tool moves over the glass surface, but movement of the experimental plates did not alter the general characteristics outlined above, nor did the presence of water afford an explanation of the results obtained in practice.

Evidently mere pounding of a glass plate cannot result in a smoothed surface of a technical order.

As in all the previous experiments the pressure was applied at the centre of the block, where the horizontal forces were balanced, a new series was carried out near the margin of the plate. The new appearance, corresponding with the stage illustrated in Fig. 1, is indicated in Fig. 9, from which it will be seen that the central cone is now deviated towards the side, its axis following the characteristic conchoidal section. In other respects the sequence of phenomena was as before. Thus, after the cone fracture which was of a shallower order took place, and the crushing point was reached, the diametral plane fracture followed the axis of the deviated central cone, and the cavity from which the splinter was removed had the characteristic conchoidal appearance.

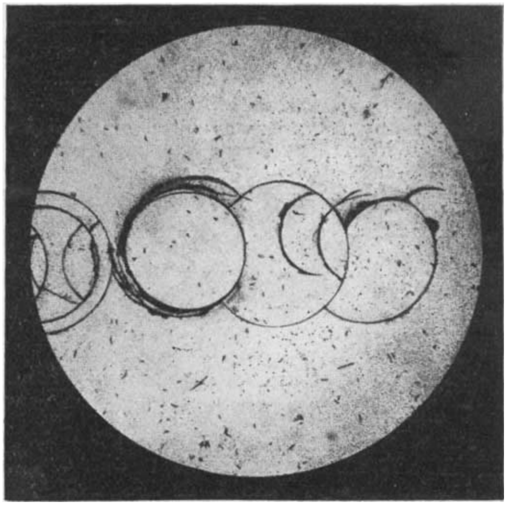

FIG. 2.—Surface percussion cracks on glass. Magnification 42×.

It is presumably the impact of the carborundum grains on the edges of cavities on the glass to be ground that produces the conchoidal splinters as indicated in Fig. 10. It would appear, therefore, that it is the diametral plane fracture that is of primary importance, and that, in the processes of smoothing, the horizontal movement is required to force the abrasive grains against the sides of the cavities. From actual tests it is found that the rate of abrasion is directly proportional to the pressure and to the relative speed of translation.

JAMES WEIR FRENCH.

Anniesland, Glasgow, October 13.

The Breeding of the King Penguin.

THE Zoological Park at Edinburgh has had the good fortune to possess, almost from its inception, a small group of king penguins. Three of the birds were received in January, 1914, from South Georgia, a second consignment, of which three survived, arriving in the spring of 1917. A hope was excited that they might breed when two of them were observed to be mating in the autumn of 1915, but nothing further occurred at that time. In the late summer of 1917 one of the birds became broody, and sat in the posture of incubation for about a month, but no egg was apparently laid, nor was this bird one of the two which had been observed to be paired. It was not until 1918 that the paired birds really settled down in earnest, and much interest was aroused when, on July 8 of that year, one of them was found to have an egg.

The king penguin, like its near relative the emperor penguin, makes no nest, but carries the single egg on its feet, where it is held in place and covered for warmth and protection by a fold of the skin and feathers of the abdomen, which, being furnished with a constricting muscle, grips the egg tightly. The brooding penguin can not only travel about with the egg in position, but even scratch its head with one foot while still holding the egg securely. Both sexes share in the work of incubation, the transfer of the egg having been observed on the second day. The parental instinct is very strong in the king penguin, not only in mated, but in the unattached birds as well. The group at this time contained three other birds, and their presence, or perhaps nothing but the very obvious conflict of desire for simultaneous possession of the egg between the husband and wife, may have been the cause of the misfortune which followed; at any rate, it was disappointing to find, after about two weeks, that the egg had been broken and that its custodian was believed to be relieving the tedium of duty by occasionally sipping its contents.

The floor of the enclosure consists of shelving rock, and to reduce the risk of breakage if an egg were produced this year, a large bed of sand was laid down. The next incident was again disappointing, for in July an egg was laid, but within an hour or so it had disappeared. As none of the birds showed any disposition to incubate it, I formed the opinion that it had been laid by one of the unmated birds, and this seemed to be confirmed when, on September 1, the female of the pair was found to have an egg. The other three birds were at once removed from the enclosure so that they should not interfere, and for two days all went well, the male bird taking the egg at night and the hen during the day. On the third day, however, the calling of one of the other birds—the third of the three originally imported—seemed to disturb the male, and he left his wife, refused to have anything more to do with the egg, and spent the day (and probably the night) in calling to the third bird and trying to get to it. After some days, as the female seemed to be suffering from the unrelieved care of the egg, and neither bird would feed, it was decided to put the third bird back. When this was done they all settled down together, and the male resumed his share in the labour, the third bird usually standing near.

The time during which each bird had the egg varied from a day to a week or more. The female when she had the egg always remained in the same place, where she made a slight hollow in the sand, but when the male had it he occasionally went for a walk round the enclosure, shuffling along with the egg on his feet. He even descended from one ledge of rock to another by turning round and working himself down backwards—a performance which led to several narrow escapes for the egg.

As the period of incubation elapsed the result was awaited with some anxiety, and it was in no small degree gratifying to find, on October 22, that the egg was chipped and the chick inside alive. It was not, however, until two days later that the chick was clear of the shell, the period of incubation thus being seven weeks and four days. The chick when hatched was comparatively small, and the skin was bare, but in a few days it increased considerably in size. The young bird, like the egg, is kept between the feet of the parent and covered by the fold of skin; it is fed at frequent intervals with semi-digested fish disgorged by the parent. As in the case of other birds which feed their young by this method, the chick places its head in the parent's mouth and takes the food from the gullet.

Apart from accident, there seems every likelihood that the young bird will be reared. It may be claimed which feed their young by this method, the chick king penguin has bred outside those islands of the Antarctic seas on which it has its home, and the record is a unique one.

T. H. GILLESPIE.

Zoological Society of Scotland, Edinburgh,
October 29.

A Helium Series in the Extreme Ultra-Violet.

IT has been shown that the helium series first discovered in a terrestrial source by Fowler can be represented by the formula

$$V = 109750\left(\frac{1}{\left(\frac{n_1}{2}\right)^2} - \frac{1}{\left(\frac{n_2}{2}\right)^2}\right),$$

where n has the value 3 or 4 (Evans, *Phil. Mag.*, vol. xxix., p. 284, 1915).

If n be given the value 2, and n_2 the successive value 3, 4, and 5, lines result at wave-length 1640·1, 1214·9, and 1084·7. My previous investigations of the helium spectrum did not afford much evidence as to the existence of these lines (*Astrophys. Journ.*, vol. xliii., p. 92, 1916); a recent search, however, has been more successful. With a powerful disruptive discharge in helium, a sharp, fairly strong line appears at 1640·2; no trace of it is found in hydrogen under the same electrical conditions, and it does not occur in helium when the discharge circuit is free from capacity. Under the same violently disruptive condition the line at 1216, always present in helium and hydrogen, develops a satellite on its more refrangible side; this satellite is not well resolved, but its wave-length appears to be about 1215·1. The region that should be occupied by 1084·7 is obscured by a strong pair at 1085, probably due to an impurity.

Owing to the difficulties of vacuum spectroscopy, it is perhaps unwise to claim that the evidence in this case is conclusive. I regard it as very probable, however, that two members of this series in helium have been found in the extreme ultra-violet.

THEODORE LYMAN.

Harvard University, October 25.